



# Effects of Spring Defoliation on First-Year Growth of Young Loblolly and Slash Pines

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## ABSTRACT

Partial and complete spring defoliation reduced first-year diameter, height, and volume growth of 4-year-old loblolly and slash pines. Early and late growth differed significantly between defoliation levels ( $P=0.05$ ). However, the number of height-growth flushes produced during the 1986 growing season was not affected by defoliation treatments. No mortality occurred during 1986. Mean volume growth loss of the 100-percent defoliated trees was 68 and 56 percent, respectively, for loblolly and slash pines.

**Keywords:** *Pinus elliottii*, *Pinus taeda*, crown scorch, fire damage, growth effects.

The relationship of season and level of fire-induced defoliation (crown scorch) to growth of young loblolly (*Pinus taeda* L.) and slash (*P. elliottii* Engelm.) pines is unknown. Wade and Johansen (1986) provide an exhaustive review of the effects of fire on southern pine; however, none of the studies reviewed examined the effects of season and level of crown scorch on growth in young pines. To better delineate this relationship, a study was established in February 1986. This paper reports first-year posttreatment growth responses to April defoliation.

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## Methods

The study was established in 4-year-old loblolly and slash pine plantations on the South Carolina, Georgia, and Florida Coastal Plains. A randomized block 4 by 5 factorial experiment was replicated 15 times in each of 4 locations (2 locations per species). One of five levels of defoliation (0, 33, 66, 95, or 100 percent) and one of four seasons of defoliation (January, April, July, or October) were randomly assigned to each of 20 trees within a replication. Foliage was hand removed from the bottom of the crown upward to simulate scorch. Care was taken not to damage the buds.

Initial tree diameter and initial total height were measured in early 1986 prior to bud elongation. Foliage was removed in April, July, or October 1986 or January 1987. D.b.h. and total height were remeasured in conjunction with the July 1986 defoliation and during the 1986-87 dormant season. The number of height-growth flushes was also determined during the latter remeasurement. Total stem volume was calculated by using equations from a total-tree multiproduct cruise program (Clark and others 1985).

Early, late, and total 1986 d.b.h., height, and volume growth were calculated for the periods March to July 1986, July 1986 to January 1987, and March 1986 to January 1987, respectively. Growth was separated into two periods to determine duration of any defoliation effects. Differences in all

growth parameters between the April defoliated trees and all undefoliated trees were tested with Tukey's multiple comparison procedure with an experiment-wise error rate of 0.05 (Steel and Torrie 1980). Growth loss was defined as the ratio of the growth difference of treated and untreated trees to the growth of untreated trees. Flush data were analyzed with the CATMOD procedure in release 85.1 of SAS (SAS Institute Inc. 1985, pp. 171-253).

## Results

Growth was significantly affected by the April defoliations. With one exception, growth of the completely defoliated trees was significantly less than growth of the undefoliated trees (tables 1-4); late diameter growth of slash pine at Waycross, GA, did not differ significantly (table 4). Mean early diameter growth of trees receiving 66 percent or more defoliation was significantly less than that of the undefoliated trees at all four locations. This trend continued with late diameter growth in the 95- and 100-percent defoliated trees. Trees with 66-percent defoliation refoliated sufficiently to equal the late diameter growth of undefoliated trees. Late diameter growth, however, was not great enough to overcome the early diameter growth loss; thus, total 1986 diameter growth of the 66-, 95-, and 100-percent defoliated trees was significantly less than growth of the undefoliated trees. Mean 1986 diameter growth loss of the completely defoliated trees was 55 and 59 percent for loblolly and slash pines, respectively (figs. 1, 2).

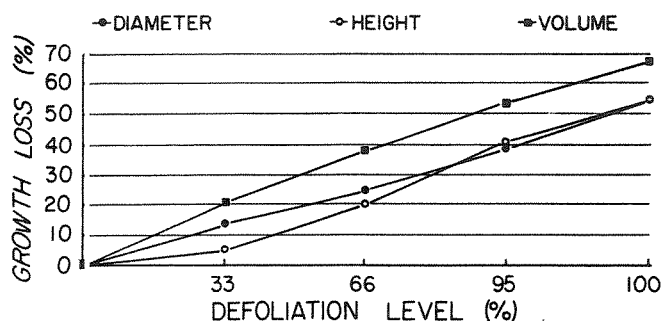


Figure 1.  
Loblolly pine growth loss with increasing defoliation.

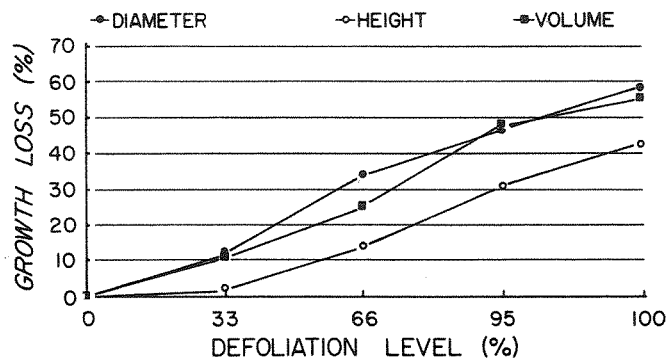


Figure 2.  
Slash pine growth loss with increasing defoliation.

Mean height growth of all 95- and 100-percent defoliated trees was also significantly less than height growth of the undefoliated trees (tables 1-4). There were generally more significant differences in height growth during the early-season growth period than during the late period. Total 1986 height growth was generally reduced by the three severe defoliation treatments; however, the number of height-growth flushes produced did not differ significantly among treatments. Height and diameter growth loss is similar in loblolly pine (fig. 1) but not in slash pine (fig. 2). Although not statistically significant, early height growth of the 33-percent defoliated trees at Branchville, SC, and Palatka, FL, was numerically greater than the growth of the undefoliated trees.

Total stem wood volume growth of the undefoliated and completely defoliated trees differed significantly at each location. Volume growth was reduced by defoliation during both the early and late growth periods. As severity of defoliation increased, volume growth loss increased (figs. 1, 2). Mean volume growth loss of the completely defoliated trees was 56 and 68 percent for slash and loblolly pines, respectively. No mortality occurred during 1986.

## Discussion and Summary

Diameter, height, and volume growth generally decreased when trees were subjected to severe levels of hand

Table 1.--Effect of spring defoliation on growth of 4-year-old loblolly pines at Branchville, SC

Variable <sup>a</sup>	Defoliation level <sup>b</sup>				
	0%	33%	66%	95%	100%
Diameter growth (in)					
Early	0.59a	0.51b	0.40c	0.25d	0.21d
Late	0.54a	0.49ab	0.50ab	0.42bc	0.35c
1986	1.13a	1.00b	0.90b	0.68c	0.56c
Height growth (ft)					
Early	2.67a	2.91a	2.19b	1.68c	1.08d
Late	1.18a	1.24a	0.93ab	0.53b	0.54b
1986	3.85a	4.15a	3.12b	2.21c	1.62d
Volume growth <sup>c</sup> (ft <sup>3</sup> )					
Early	0.062a	0.052ab	0.035bc	0.023c	0.018c
Late	0.076a	0.066ab	0.055bc	0.037cd	0.031d
1986	0.138a	0.118ab	0.090bc	0.060cd	0.049d

<sup>a</sup>Early growth = March to July 1986; late growth = July 1986 to January 1987.

<sup>b</sup>Means followed by the same letter do not differ significantly (Tukey,  $P=0.05$ ).

<sup>c</sup>Estimated with equations from total-tree multiproduct cruise program (Clark and others 1985).

Table 3.--Effect of spring defoliation on growth of 4-year-old slash pines at Palatka, FL

Variable <sup>a</sup>	Defoliation level <sup>b</sup>				
	0%	33%	66%	95%	100%
Diameter growth (in)					
Early	0.33a	0.28a	0.15b	0.12bc	0.07c
Late	0.25a	0.24a	0.23ab	0.16bc	0.15c
1986	0.58a	0.52a	0.38b	0.28c	0.23c
Height growth (ft)					
Early	3.37a	3.51a	3.30a	2.23b	1.97b
Late	0.65a	0.58ab	0.41b	0.39b	0.38b
1986	4.01ab	4.08a	3.71ab	2.62c	2.35d
Volume growth <sup>c</sup> (ft <sup>3</sup> )					
Early	0.54a	0.053ab	0.040bc	0.026cd	0.023d
Late	0.36a	0.034a	0.032ab	0.018c	0.019bc
1986	0.090a	0.086a	0.072a	0.044b	0.042d

<sup>a</sup>Early growth = March to July 1986; late growth = July 1986 to January 1987.

<sup>b</sup>Means followed by the same letter do not differ significantly (Tukey,  $P=0.05$ ).

<sup>c</sup>Estimated with equations from total-tree multiproduct cruise program (Clark and others 1985).

defoliation in April. However, height growth of trees defoliated 33 percent was numerically, although not statistically, greater than that of undefoliated trees. Other studies have reported stimulation of height growth through the removal of lower crown foliage (Gruschow 1952; Johansen 1975).

Partial and complete defoliation did not affect the number of height-growth flushes produced during the 1986 growing season. The fact that the

Table 2.--Effect of spring defoliation on growth of 4-year-old loblolly pines at Bainbridge, GA

Variable <sup>a</sup>	Defoliation level <sup>b</sup>				
	0%	33%	66%	95%	100%
Diameter growth (in)					
Early	0.45a	0.37b	0.32b	0.22c	0.16c
Late	0.42a	0.35ab	0.30bc	0.31b	0.20c
1986	0.87a	0.72b	0.62bc	0.53c	0.36d
Height growth (ft)					
Early	2.39a	2.25a	2.16ab	1.63bc	1.22c
Late	0.84a	0.35b	0.39b	0.36b	0.30b
1986	3.23a	2.61b	2.55b	1.98bc	1.52c
Volume growth <sup>c</sup> (ft <sup>3</sup> )					
Early	0.037a	0.028ab	0.023bc	0.017bc	0.013c
Late	0.044a	0.028b	0.023bc	0.022bc	0.014c
1986	0.081a	0.056b	0.047bc	0.039bc	0.028c

<sup>a</sup>Early growth = March to July 1986; late growth = July 1986 to January 1987.

<sup>b</sup>Means followed by the same letter do not differ significantly (Tukey,  $P=0.05$ ).

<sup>c</sup>Estimated with equations from total-tree multiproduct cruise program (Clark and others 1985).

Table 4.--Effect of spring defoliation on growth of 4-year-old slash pines at Waycross, GA

Variable <sup>a</sup>	Defoliation level <sup>b</sup>				
	0%	33%	66%	95%	100%
Diameter growth (in)					
Early	0.35a	0.30ab	0.22bc	0.13c	0.14c
Late	0.24a	0.20a	0.016a	0.20a	0.10a
1986	0.58a	0.50ab	0.38bc	0.33c	0.25c
Height growth (ft)					
Early	2.73a	2.62ab	2.25bc	2.09c	1.66d
Late	0.34a	0.28ab	0.17bc	0.14bc	0.06c
1986	3.07a	2.90a	2.42b	2.23b	1.72c
Volume growth <sup>c</sup> (ft <sup>3</sup> )					
Early	0.051a	0.044ab	0.038bc	0.025c	0.024c
Late	0.031a	0.024ab	0.019ab	0.021ab	0.010b
1986	0.083a	0.068ab	0.058bc	0.045bc	0.035c

<sup>a</sup>Early growth = March to July 1986; late growth = July 1986 to January 1987.

<sup>b</sup>Means followed by the same letter do not differ significantly (Tukey,  $P=0.05$ ).

<sup>c</sup>Estimated with equations from total-tree multiproduct cruise program (Clark and others 1985).

number of flushes produced was not affected by the treatments and that none of the April defoliated trees died suggests that mortality following fire is due to bud, cambium, or root mortality. Upcoming measurements should quantify the importance of season to postfire survival and growth of these two southern pines.

Note the magnitude of the volume growth loss (figs. 1, 2) of the completely defoliated trees. Even though

the trees are still alive, they have lost more than half of 1 year's growth. Volume growth loss occurred at all levels of April defoliation. Whether this growth loss is temporary or not has yet to be determined, but these preliminary results reaffirm that early growing-season fires have the potential to depress volume growth for at least 1 year following the fire.

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